Space Weather Technical Forecast

Issued on Wednesday, 16 March 2022 at 12:17 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Moderate Solar activity with a chance of further M-flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours with a couple of M-Class flares observed from AR2965 Fai/Beta-gamma. This has exhibited some development of small spots to the north of the region, potentially causing the instability and the subsequent flare activity, despite some simplification elsewhere in the region. There are three numbered sunspot region on the disc in total, with the other two regions AR2970 Bxo/Beta and AR2976 Hsx/alpha both small and simple. A further relatively sunspot region is also evident on the northeast limb. No Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, have been slow-ambient to slightly elevated levels 360-430km/s. Density was at near average levels, around 5ppcc. The strength of the interplanetary magnetic field (IMF), Bt, was weak and gradually eased from 7nT to around 3nT. The north-south component, Bz, was Weak and ranged from -6nT to +7nT. Phi angle was mostly negative (towards the sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was very slightly above background, likely due to a far-sided flare from just over the southwest limb, but well below the S1 level and has now eased back towards background. The high energy electron flux (greater than 2 MeV) has been at background. The 24-hour integrated electron fluence was below the Active (1e8 integrated pfu) threshold. Observed fluence at 16/0000 UTC was 1.51e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be at mostly Low levels with an ongoing chance of an isolated M-class flare from AR2965.

Solar Wind / Geomagnetic Activity: There is one slow weak CME observed from a filament lift off the southern disc on 13 March. This will likely pass south of the Earth, but may give a glancing impact on day 2 (17th). No coronal hole sourced enhancements are currently expected during this period. Geomagnetic activity is likely to be predominantly Quiet, with the greatest chance of any significant increases in activity to Active (Kp4) if we do see the weak CME on Day 2 (17th).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain predominantly at background levels, although there is a slight chance of an increase in response to any larger flares that may occur. The high energy (greater than 2 MeV) electron flux is currently at background levels, however there is still the potential for an increase

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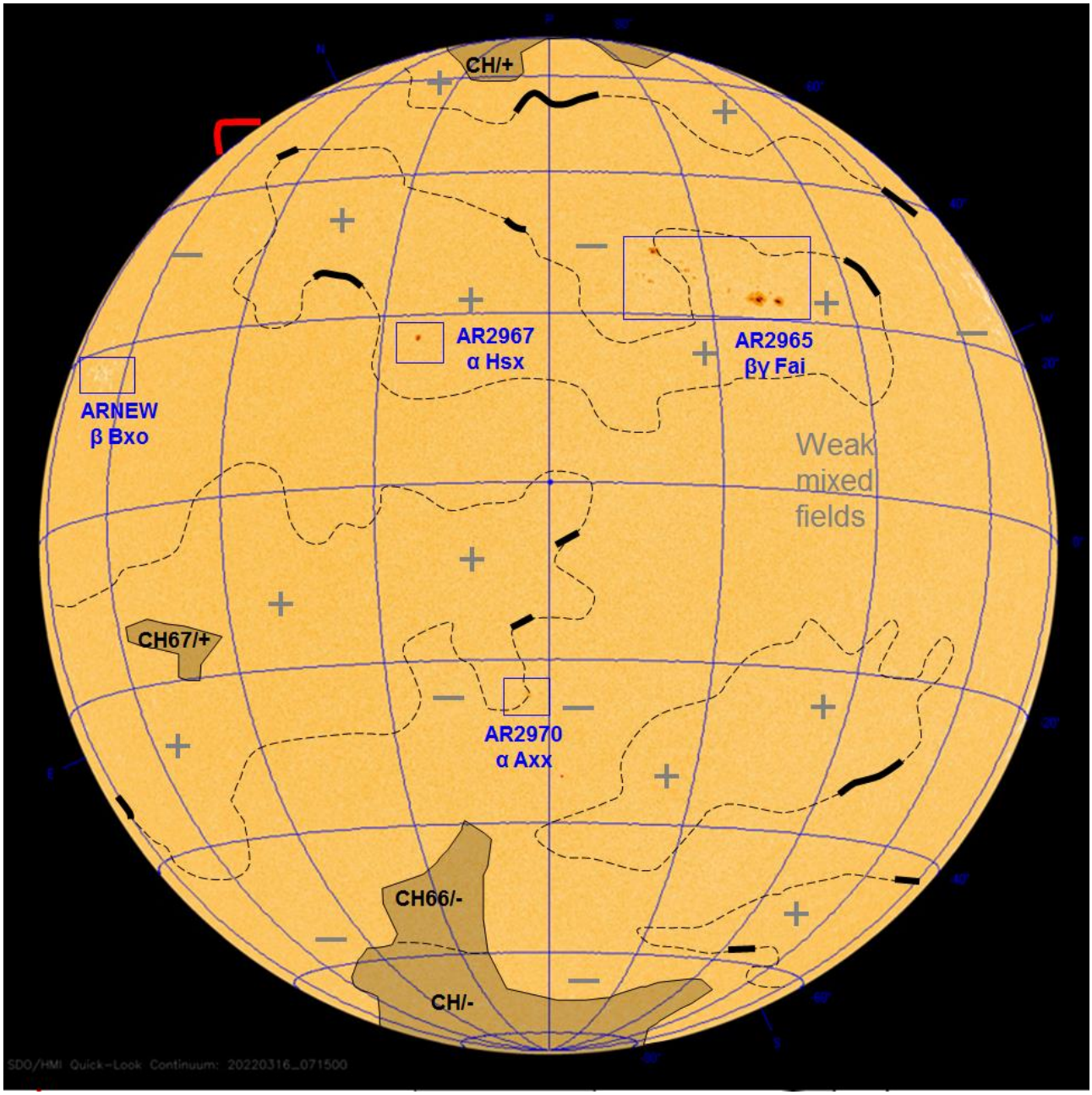
in flux through days 1 and 2 (16th and 17th), The electron fluence might start following a gently rising trend if we see an electron response, but is not expected to reach the Active threshold.

Figure 1. Solar Analysis Valid 0800 UTC, 16 March 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

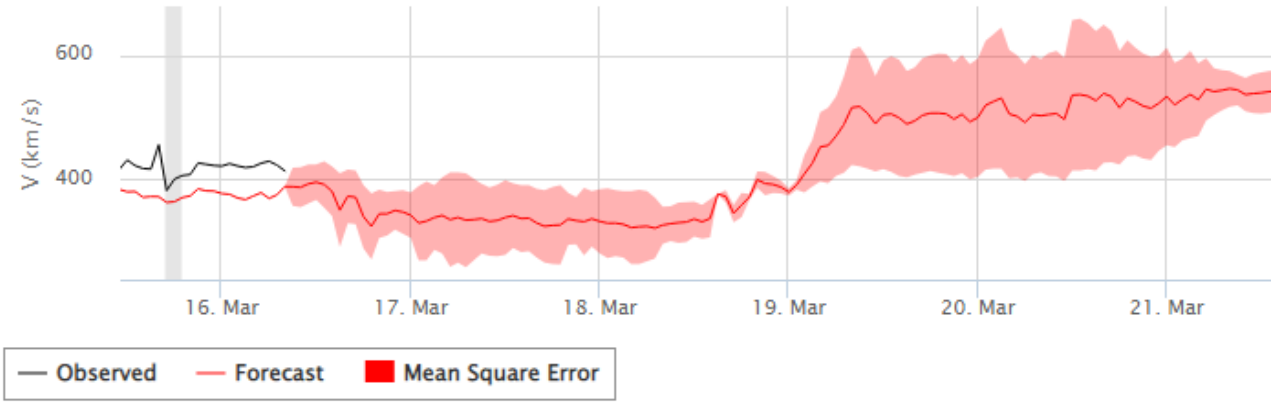
Recent CME enhancements have now eased, with solar winds at or near background. There is a CME expected to pass to the south of Earth on day 2 (17th), from a filament lift on the 13th. This has a low chance of bringing a glancing impact, and giving a chance of Unsettled to Active intervals and a slight chance of G1 Minor Storm intervals.
No other enhancements are expected with the next coronal hole fast wind arrival potentially on the 20th (day 5) from CH66/-, a northern extension of the southern crown coronal hole.
Geomagnetic activity is expected to remain Quiet with only isolated Unsettled intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
13/2018	Partial	Filament	17W/33S	380	Miss	Small chance of glancing blow on 17th

Figure 2: Met Office SWPM output showing possible increase over weekend but may be 24hrs too early.



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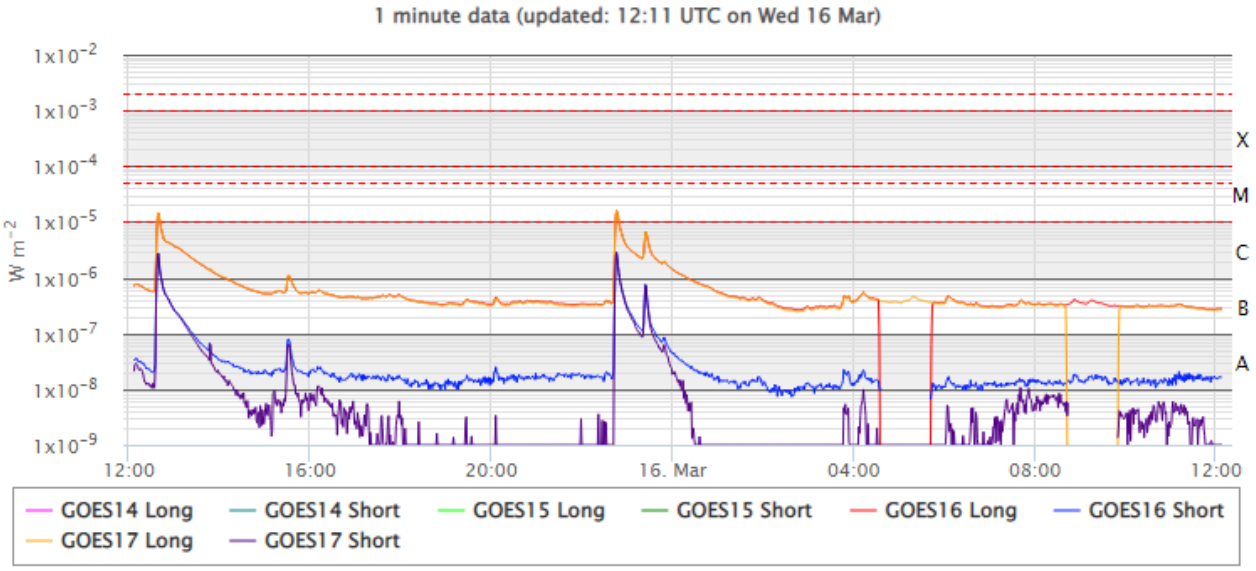
Radio Blackouts - X-Ray Flares:
Solar Activity is currently Moderate with three numbered sunspot regions on the visible disc. AR2965 Fai/Beta-Gamma, just west of the north-centre disc has been the source of the activity with 2 M-flares (M1.4 at 15/1239UTC and M1.6 at 15/2246UTC) and a number of C-flares. This is a longitudinally wide region, consisting of numerous small spots and appears to have been destabilised by the emergence of new spots in close proximity to the north. Further isolated M-flares are probable from this region over the next couple of days.
All other regions, are much smaller and generally inactive. AR2967 Hsx/alpha and AR2970 Bxo/Beta are both faint and stable. A further relatively new, but small region is evident near the northeast limb with little obvious development so far. Activity is forecast to continue mostly Low with a chance of further M-flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	50	40	30	30
Very Active	R3 to R5 X Class	No	5	2	2	2

Figure 3: X-ray flux plot at GEO showing various flares, including two at M-class.



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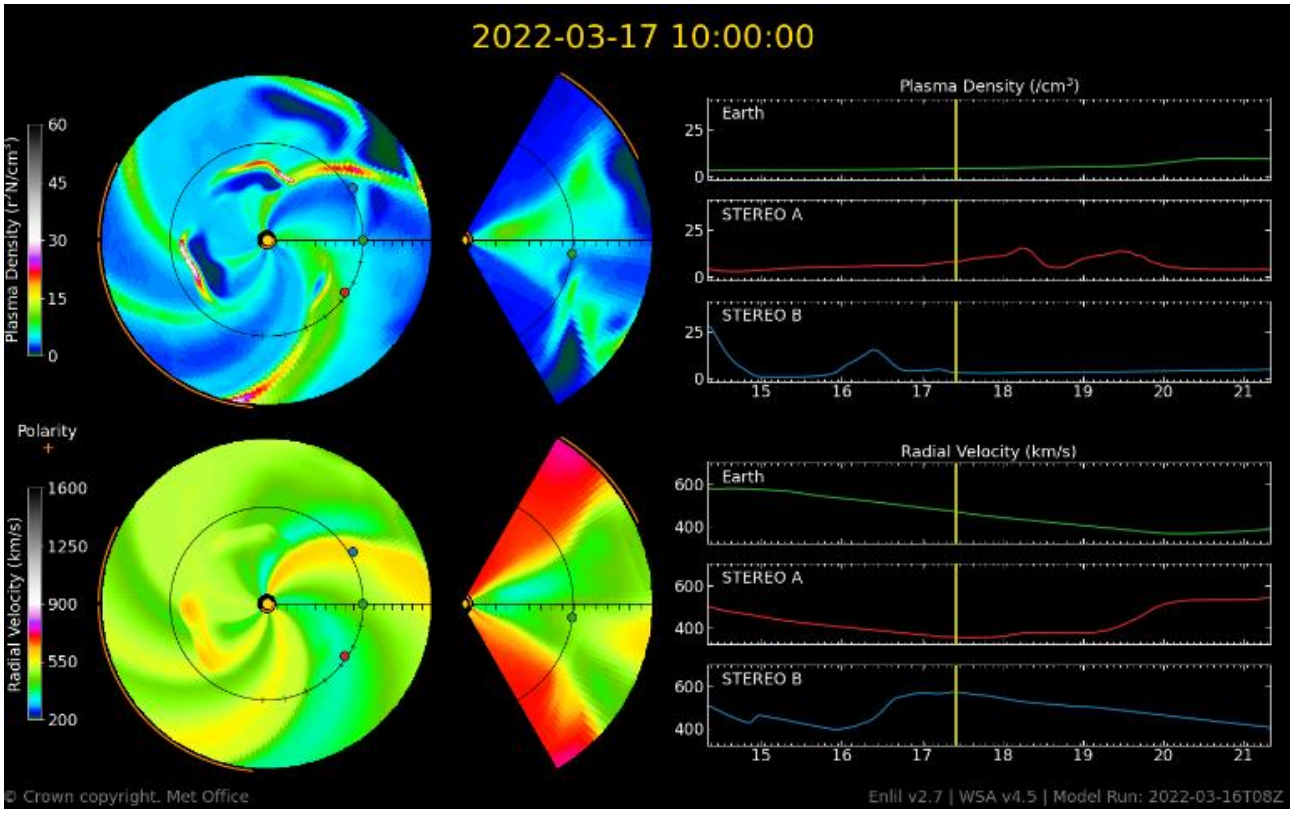
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES-16 lifted slightly above background levels early on 15 March, likely due to a far-sided flare, with subsequent CME observed off the Southwest of the disc. This peaked at just over 1pfu, before declining back towards background, remaining well below the S1 level. Further such enhancements are possible from any large flares from AR2965, with only a slightly above background chance of reaching the S1 level. Otherwise background levels are expected to persist.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	2	2	2
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Met Office ENLIL output showing glancing blow from CME on 17 March.



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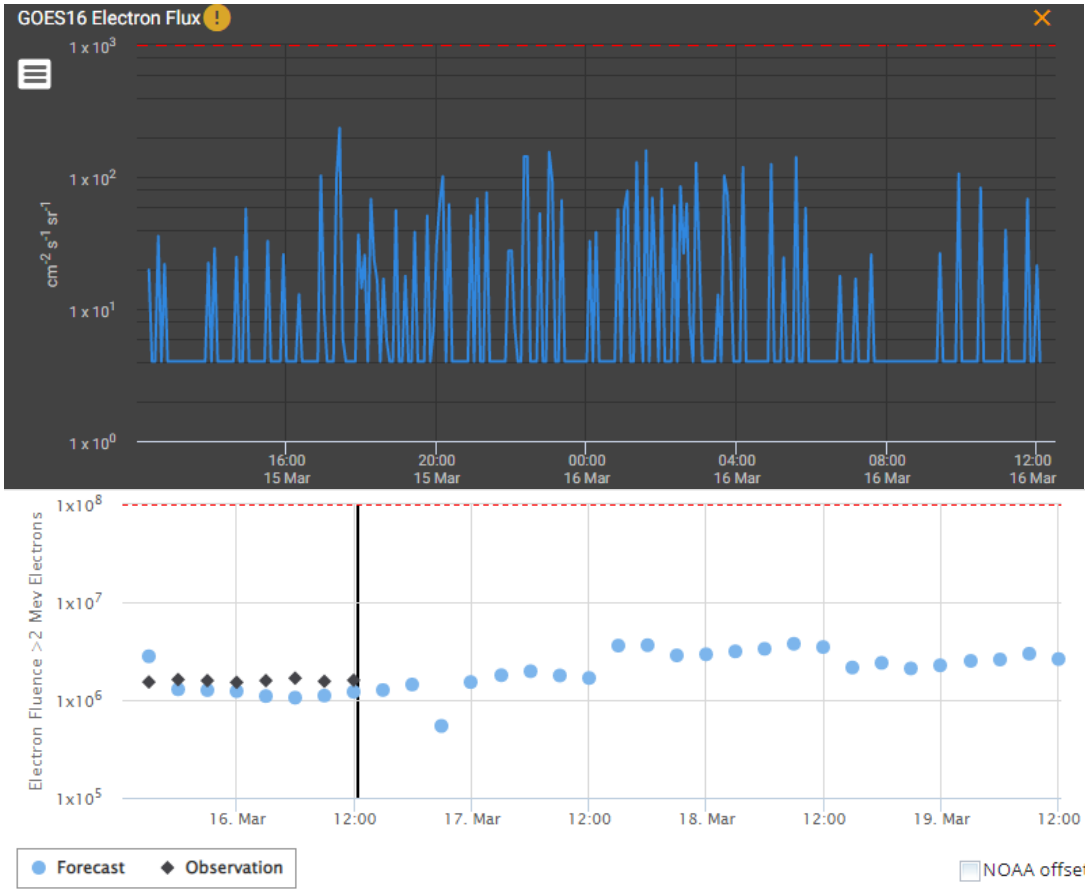
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed at GEO by GOES-16 is currently at background levels. Recent CME arrival appears to have not increased flux levels at GEO, however there is still the potential for observed flux levels to build through day 1 and day 2 (16th and 17th), although this is very low confidence. No other sources of enhancement are currently expected in the period. The slight chance of a glancing CME day 2 (17th), decreasing this confidence further.

The associated 24 hour electron fluence is well below the Active level, and expected to remain at this level with a possible gently rising trend if there is a response in electron flux levels over the coming few days. This is supported by REFM, which appears to be giving good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux and associated fluence levels with REFM output over the past 24 hours.



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